Miniature Robot and Mechanism Lab

Introduction

YNU FUCHIWAKI Lab

for Unique & Creative Innovation

This movie is introduction of the miniature robot and mechanism laboratory from the supervisor.

Contents

- Research Concept
- Four main technologies on the manufacturing in robotics and mechatronics

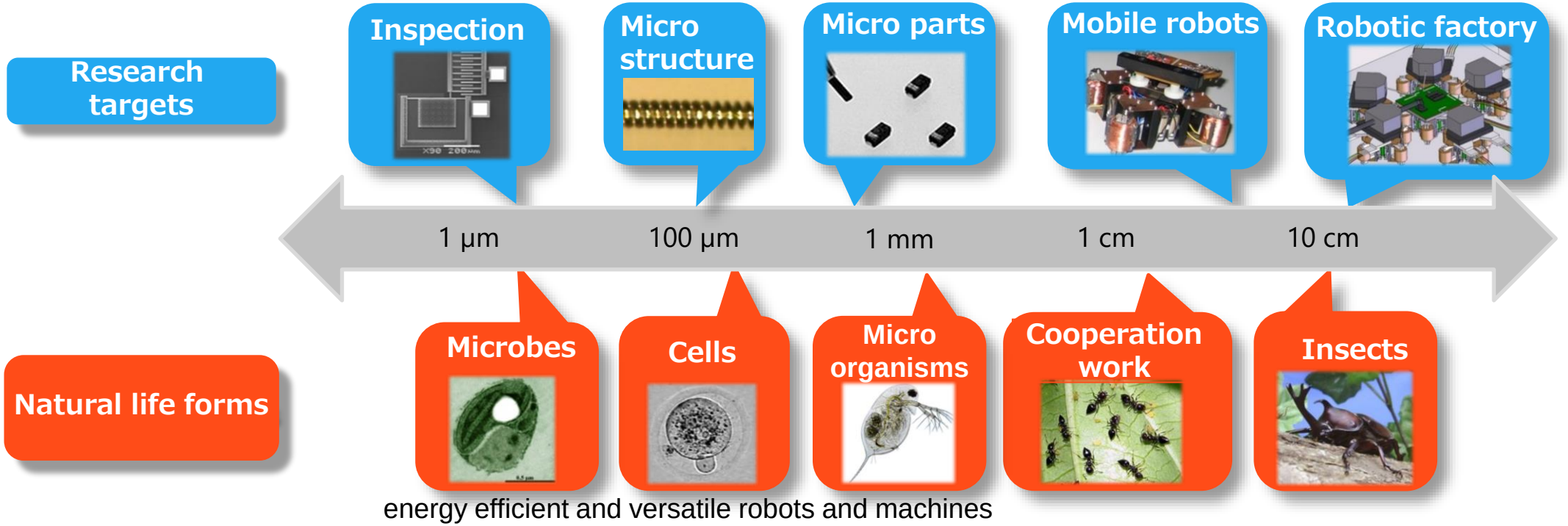
  Hardware (Mechanism, Electro Circuit), Software（Control, Simulation）
- Guidance Policy
- Research subjects
- Messages

These are contents of the presentation. First of all, I explain the research concept and overlook the four main technologies on the manufacturing in robotics and mechatronics, such as mechanism, electro circuit, control, and simulation. Then, I explain research guidance policy, subjects, and messages.

Motivation

“Creation of miniature and versatile robots which are comparable to insects”

<Keywords>
Mechanism, actuator, mobile robot, measurement, control, manipulation, cooperation



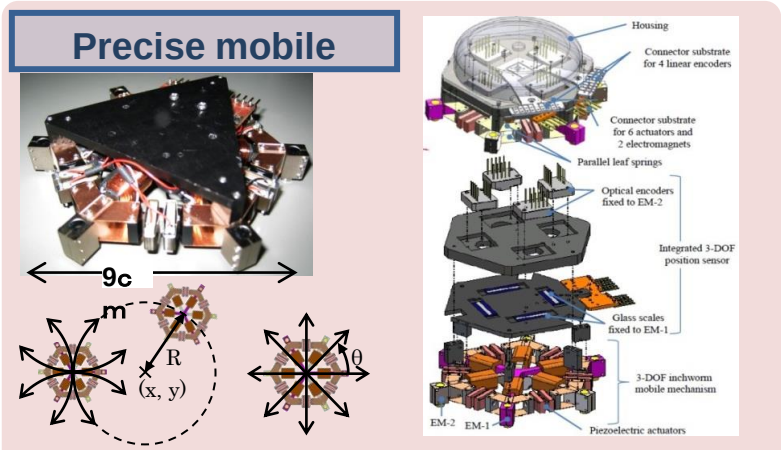
Motivation of this laboratory is “creation of miniature and versatile robots which are comparable to insects”. This figure shows the classification of the research targets and the natural life forms by their size. Develop goal is creation of energy efficient and versatile robots from beetles to microbe’s size. Keywords are mechanism, actuator, mobile robot, measurement, control, manipulation, and cooperation.

4 skills for Manufacturing

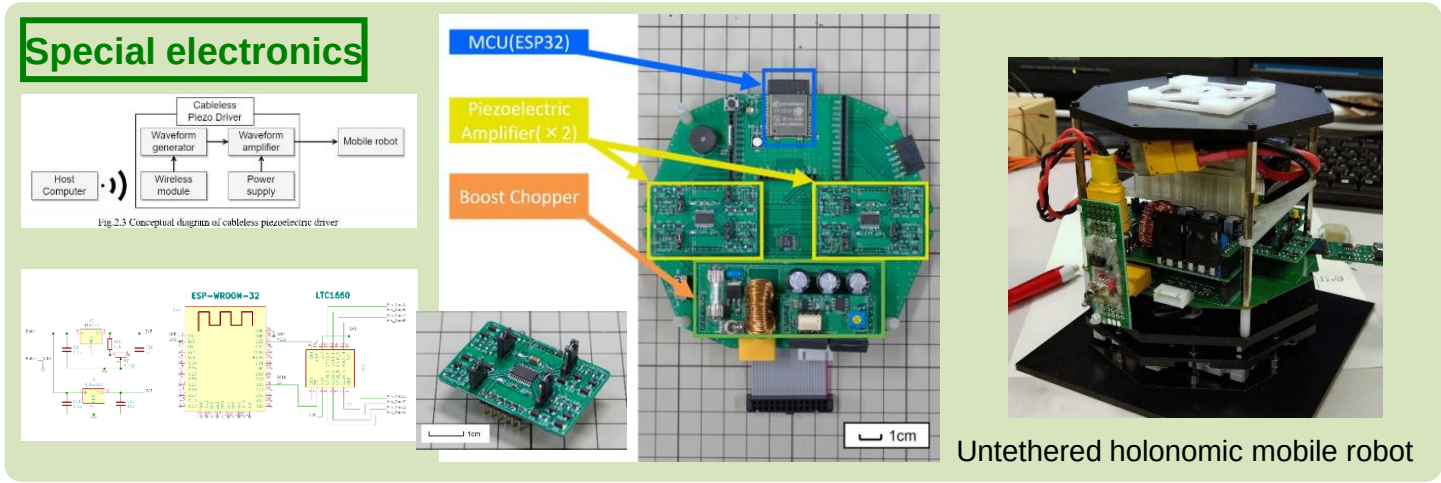
Hardware

1. 「**Mechanism**」
   Design and fabrication of Machine, robot, actuator, vehicle, manipulator

2. 「**Electro circuits**」
   Electronic work, power supply, measurement, signal processing



Holonomic mobile robot with electromagnets and PZT



Untethered holonomic mobile robot

This laboratory focused on the four skills for manufacturing. Mechanism is suitable for people who are interested in desig and fabrication of actual objects such as machine, robot, actuator, vehicle, and manipulator. Electro circuits are suitable fo people who are interested in electronic work, power supply, measurement, and signal processing.

Software

3.「Control」

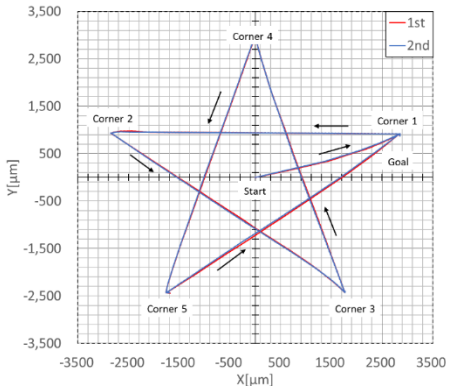
Controlling machines and robots as you want
by Quasi-optimal Control, Machine learning, AI etc.

4.「Simulation」

・Numerical calculation of mechanism and micro fluidics

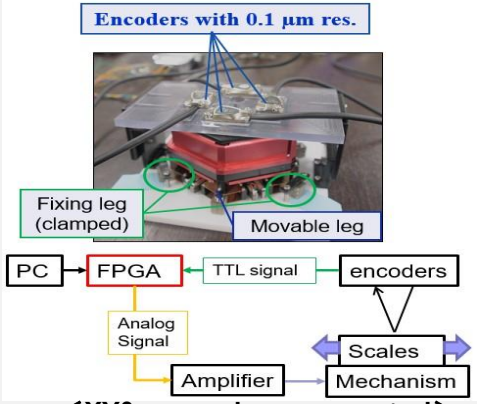
・Increase efficiency of the design, creation of new design

⇒Interesting in Theory and Analysis

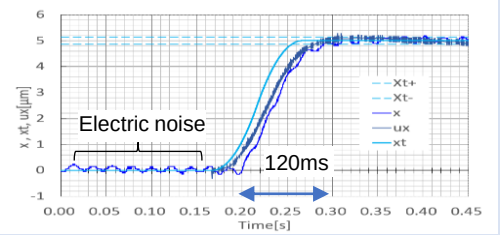


Star shaped precise navigation

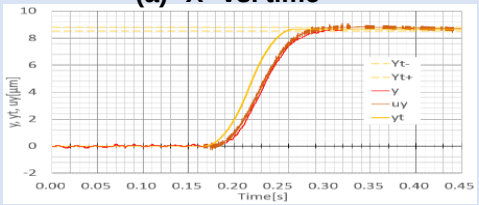
Measuring & Control



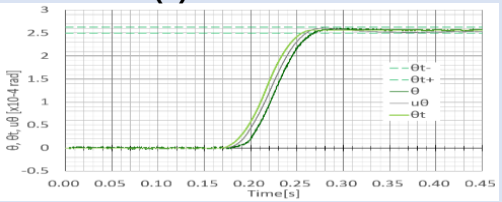
<XYθ nm-scale servo control>



(a) X vs. time

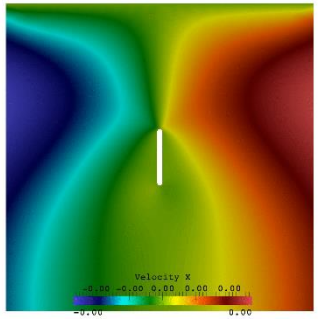


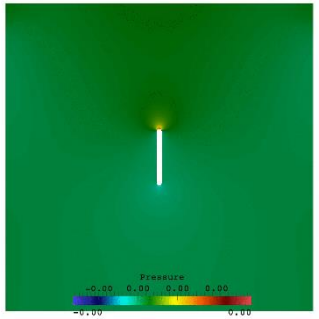
(b) Y vs. time



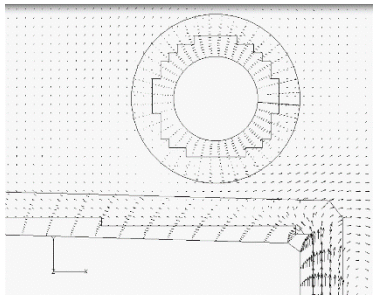
(c) Θ vs. time

Precise position control

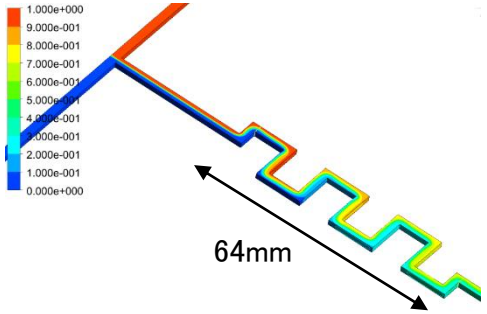




Numerical calculation for velocity and pressure fields



2D Local flow around vibrated pipette



Micro mixing simulation using CFD

Which skills are you interested in ?

Control is fitted for those who are interested in controlling machines and robots as you want.
Simulation is suited for those who are interested in theory and analysis, numerical calculation, optimization of the design

Guidance policies

1. Research subject should be challenging and just the right difficulty for each student

2. Learning manufacturing process such as
   Investigation >Idea >Proof of concept >Evaluation >Publication

3. Sufficient discussion and communication between students & supervisor

4. Increase efficiency for learning and data acquisition

5. Flexible guidance according to each individuality and character

There are 5 guidance policies. 1 Challenging, and just the right difficulty research subject for each student
2 Learn manufacturing process Concept > Prototype > Evaluation > Improvement > Publication, 3 Discussion and communication,
4 Increase efficiency for learning and data acquisition, 5 Flexible guidance according to each individuality and character

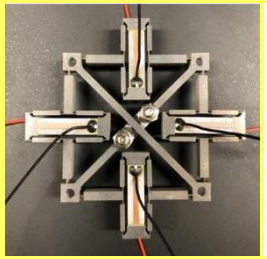
Research subjects

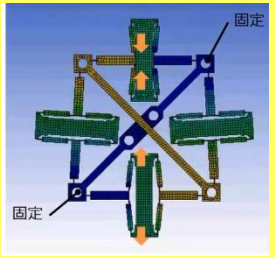
①Mobile robot
- ・Mechanical design
- ・Electro circuit for untethered robot, Charge FB circuit for piezoelectric actuators
- ・XYθ displacement sensor with 4 encoders
- ・Precise positioning control using FPGA with FB cycle of 10μs.

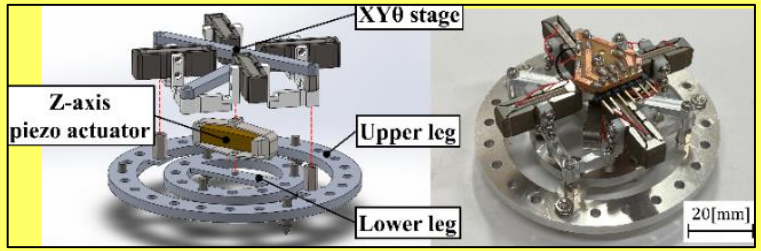
②Precise manipulation
- ・Manipulation in atmosphere：Liquid-bridging force gripper for complex and soft objects
- ・Manipulation in liquids：multi-axial manipulation of tiny objects by acoustic streaming
- ・Image FB control for automation of assembly of micro parts.

③Smart actuator
- ・Shape memory alloy (SMA) actuators（Collaboration with the company）
- ・Ultrasonic motors and levitations using piezoelectric actuators
- ・Control of piezoelectric actuators under frictional condition

Fine Mech. design

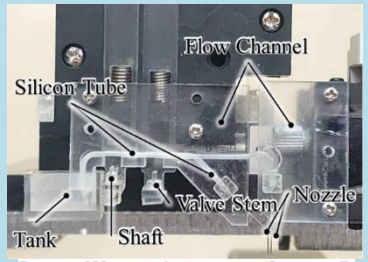




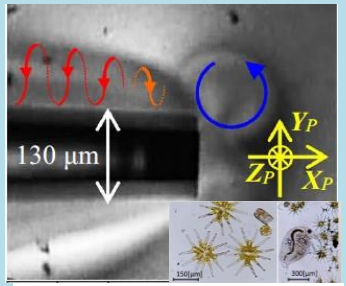


Alternating tripod gait holonomic mobile robot

Precise Tools



[Capillary force gripper]



[Acoustic streaming]

[Micro parts assembly]

Messages from alumni

If you just concentrate and take a lot of time from April,
you surely get enough results and development skills.

Self-motivated actions are significant in
Investigation of references, Learning related theory, suggestion of method,
Planning of Experiments for Data acquisition, and Evaluation.

Your skills and comprehension are raised more and more thorough
Submission of Journal papers and response reviewer’s comments, and
Presentation at domestic and international conferences.

Message from supervisor

If you just concentrate and take a lot of time for first time researching, you definitely get enough research results.

You will understand the satisfaction of acquiring knowledge and technology.

Your life will be full of discoveries and joys of accomplishment.

If you have any questions, please feel free to send messages.

This slide shows the message from supervisor. If you just concentrate and take a lot of time for first time researching, you definitely get enough research results. Then you will also acquire the satisfaction of acquiring knowledge and technology in your whole life; Your life becomes full of discovery and joys. Your life will be full of discovery and joys of accomplishment.